ECE 2305 – Introduction to C Programming

Programming Project 03

Calculating Pi

Program Features: Looping structure, variables, data input and output, mathematical

operators, function calls.

The German mathematician Gottfried Wilhelm von Leibniz used the following infinite

series of numbers in an early calculation of an approximate value for the transcendental

number Pi:

𝜋 = ∑(−1)𝑘 ( 4

2𝑘 + 1 )

∞

𝑘=0

Use a FOR loop to make a C++ program that uses Leibniz’s series to calculate and display

an approximate value for Pi by keeping a finite number of terms, 𝑁. This truncated series

approximation for Pi has the formula

𝜋 ≅ ∑(−1)𝑘 ( 4

2𝑘 + 1 )

𝑁

𝑘=0

Use double-precision floating-point numbers in performing the calculations.

Use a FOR loop to calculate an approximation of Pi for 𝑁 = 0, 𝑁 = 1 ... to 𝑁 = 15. Find

the % 𝑒𝑟𝑟𝑜𝑟 for each value of 𝑁, according to the formula

% 𝑒𝑟𝑟𝑜𝑟 = (𝑎𝑝𝑝𝑟𝑜𝑥𝑖𝑚𝑎𝑡𝑒 𝑣𝑎𝑙𝑢𝑒 𝑜𝑓 𝜋 − 𝑎𝑐𝑡𝑢𝑎𝑙 𝑣𝑎𝑙𝑢𝑒 𝑜𝑓 𝜋) × 100

𝑎𝑐𝑡𝑢𝑎𝑙 𝑣𝑎𝑙𝑢𝑒 𝑜𝑓 𝜋

For the actual value of Pi, use the value found from

double const PI = 4\*atan(1);

After each calculation display 𝑁, the approximated value of Pi, the actual value of Pi and

the % 𝑒𝑟𝑟𝑜𝑟 on the screen. The first few lines in the output should look something like

the following illustration.

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Student Name

ECE 2305

Programming Project 03

Leibniz Series Approximation of Pi

N Approximate Value Actual Value % Error

0 4.00000000000 3.14159265359 27.3239544735

1 2.66666666667 3.14159265359 - 15.1173636842

The first column is the value of 𝑁, the second column is the approximate value of Pi, the

third column is the actual value of Pi and the fourth column is the % 𝑒𝑟𝑟𝑜𝑟.

Set the number of decimal points that are shown in the display with the following code.

These line should be executed only once.

cout.setf(ios::fixed);

cout.setf(ios::showpoint);

cout.precision(15)

To document your work, create a Word document. Include the following material in the

document.

A. A brief description of the purpose of the program and the structure of the program.

The purpose of this program is to find the value and percent error of Leibniz’s formula for PI.

It uses a nested for loop to complete this task.

B. A Flowchart to illustrate the structure of the program.

A graph paper with writing on it

Description automatically generated

A screenshot of a computer program

Description automatically generated

Leibniz Series Pi Approximation

N Approximate Value of PI Actual Value of PI % Error

0 4.000000000000000 3.141592653589793 27.323954473516274

1 2.666666666666667 3.141592653589793 -15.117363684322473

2 3.466666666666667 3.141592653589793 10.347427210380774

3 2.895238095238096 3.141592653589793 -7.841709142978686

4 3.339682539682540 3.141592653589793 6.305396909634240

5 2.976046176046176 3.141592653589793 -5.269508042503606

6 3.283738483738484 3.141592653589793 4.524642301613038

7 3.017071817071818 3.141592653589793 -3.963621329954712

8 3.252365934718877 3.141592653589793 3.526023050840364

9 3.041839618929403 3.141592653589793 -3.175237710923643

10 3.232315809405594 3.141592653589793 2.887807740196187

11 3.058402765927333 3.141592653589793 -2.648016367347996

12 3.218402765927333 3.141592653589793 2.444941811592660

13 3.070254617779185 3.141592653589793 -2.270760205944973

14 3.208185652261944 3.141592653589793 2.119720982796963

15 3.079153394197428 3.141592653589793 -1.987503355058397

Press any key to continue